Unplanned Scrams with Loss of Normal Heat Removal PI White Paper

PROBLEM

Agency and industry experience in using performance indicators (PIs) has resulted in many insights and lessons learned, including to the extent possible, PIs must use a definitive criteria when evaluating an event or condition. Without clear criteria, the PI loses efficiency and effectiveness due continuous reinterpretations of the same guidelines. This "interpretation creep" erodes industry, regulator, and public confidence in the process. Clear criteria for evaluating events is essential for the implementation and understanding of the industry, the staff, and most importantly the public. Additionally, a clear standard allows events to be dispositioned in a timely manner in order to avoid additional burdens on the already limited resources available, and to permit timely regulatory engagement, as warranted.

Due to numerous FAQs and comments from the annual surveys of stakeholders, it is apparent there continues to be confusion and disagreement on the implementation of the unplanned scrams with loss of normal heat removal PI.

PURPOSE

The purpose of this paper is to clarify the NRC staff's position regarding the implementing guidance for the unplanned scrams with loss of normal heat removal performance indicator as detailed in NEI 99-02 Revision 2.

BACKGROUND

The unplanned scrams with loss of normal heat removal performance indicator monitors a subset of unplanned scrams that are more complicated and may be somewhat more risk significant. These more complicated scrams are caused by or involve a loss of the normal heat removal path prior to establishing reactor conditions that allow use of the plant's normal long term heat removal systems. This indicator is intended to count all scrams while critical that were caused by any of the following:

- complete loss of all main feedwater flow
- insufficient main condenser vacuum to remove decay heat
- complete closure of at least one MSIV in each main steam line
- failure of turbine bypass capacity that results in insufficient bypass capability remaining to maintain reactor temperature and pressure.

Additionally, any scram where one of the four above conditions occurs before establishing reactor conditions that allow use of the plant's normal long term heat removal systems is counted. The indicator allows credit for restoration of the normal heat removal path if it is easily recoverable from the control room without diagnosis or repair.

A number of FAQs and the recent internal NRC and external stakeholder surveys indicate a lack of understanding or clear interpretation of what constitutes a loss of normal heat removal path under this PI. Although the shear number of FAQs is a concern, the amount of time invested,

resources expended in developing answers, and the period of time that passes before a final answer is published represents the larger concern. In particular, draft FAQs 27.3 (LaSalle) and 28.3 (Perry), have been unresolved for nearly a year[1] because members of the ROP working group have been unable to reach agreement on a consistent interpretation of the PI.

During the most recent annual survey of external stakeholders, NEI submitted the following comment:

> In general, NEI 99–02 provides clear guidance; however, significant confusion still exists in the Scrams with Loss of Normal Heat Removal indicator which must be addressed. We recommend that this indicator be suspended until the weaknesses in this indicator (including basic purpose, definition, impact on operations, and thresholds) can be resolved.

Within the same survey, Strategic Teaming and Resource Sharing (STARS)[2] commented:

> NEI 99-02 provides adequate guidance regarding PIs. ...some changes have clarified NEI 99-02 but some have complicated it. For example, the clarifying notes in the Scrams with Loss of Normal Heat Removal PI include several special considerations, which have complicated the PI. We recommend that NEI and the NRC avoid complicating NEI 99-02 by resisting changes to the general guidance to accommodate special cases or exceptions.

As these examples illustrate, the interpretation of the PI's criteria for evaluating events is not simple and clear and as a result prevents the consistent counting of events. This paper outlines the NRC staff's proposed interpretation of the guidance and sets the precedent for moving forward in analyzing events within this indicator.

DISCUSSION

Originally, the scrams with loss of normal heat removal PI was developed based on information gathered by Idaho National Engineering and Environmental Laboratory (INEEL), NUREG/CR-5750, from industry submitted Licensee Event Reports (LER) from 1987 to 1995. INEEL compiled all scram LERs and classified them based on the text of the submitted LER. The events were coded by initial plant fault and any functional impacts. During this coding, INEEL used a two person independent review of the LERs. Each reviewer conservatively coded all of the LERs in accordance with the provided definitions. In any case were the two reviewers disagreed, the reviewers met, discussed the LER, and agreed to a final coding. Once all the LERs were

[1]Both FAQs were submitted following PI verification inspections. The event in FAQ 27.3 occurred on 04/06/01 and was submitted 01/25/02. The event in FAQ 28.3 occurred on 12/15/01 and was submitted on 03/21/02.

[2]The STARS group consists of six plants operated by TXU Electric, AmerenUE, Wolf Creek Nuclear Operating Corporation, Pacific Gas and Electric, STP Nuclear Operating Company, and Arizona Public Service.

evaluated, the resulting data showed four classifications of events, total loss of feedwater flow (P1), inadvertent closure of all MSIVs (L1), loss of condenser vacuum (L2), and turbine bypass unavailable (L3), made up a robust number of complicated scram events. Other events, such as loss of offsite power or steam generator tube rupture, represented an insignificant number of occurrences and would generate NRC attention on their own. Therefore, these four classes of events were combined into the unplanned scrams with loss of normal heat removal PI within the ROP. The INEEL report was used to determine the thresholds for the PI, and was intended to be the model the PI followed when counting scrams.

The green/white threshold was initially set at 4 scrams with loss of normal heat removal per 3 years based on a statistical analysis of the INEEL data and the individual plant examinations for severe accident vulnerabilities (IPE) averages. This threshold was revised following the 6 month pilot of the ROP and a further analysis of the data from INEEL. To refine the thresholds, the data was organized into histograms based on the number of scrams for a given plant in order to identify outliers from industry norms. Additionally, the statistical analysis of the INEEL data was re-analyzed and minor errors were corrected. The historical data submitted for the ROP, 1997 to 1999, was also analyzed using this histogram method, and the resultant green/white threshold in all cases was 2 scrams per 3 years. Consequently this is the green/white threshold established for initial implementation of the PI. The 1995 to 1997[3] data was analyzed via histograms when it became available, and the same 2 scram threshold resulted.

The higher thresholds of 10 for the white/yellow and 20 for the yellow/red were based on an iterative analysis of PRAs. PRAs from plants of various designs and manufacture were analyzed for different numbers of these types of scrams and the values of 10 and 20 were on the average equivalent to a ?CDF of 10^{-5}/yr and 10^{-4}/yr respectively. In the three years of the ROP, three plants have crossed the green/white threshold and none have crossed any higher thresholds.

The INEEL data used to determine the green/white threshold for the PI included all scrams with P1, L1, L2, and L3 initial plant faults or functional impacts. When counting scrams within the PI, the classification was clear when the scram was due to an the initial plant fault such as a closure of the MSIVs or a total loss of feed. Counting scrams solely as a result of a follow on functional impact was less clear. For example, questions have been submitted related to the inclusion of turbine man feedwater pump trips and MSIV closures.

Within the INEEL data, a loss of feed was counted when turbine main feedwater pumps trip following a scram as noted in the following LERs.

[3]In developing the ROP, two key principles were 1) that industry has undergone significant improvement in safe operating performance since the late 1980's and early 1990's and by the 1995 to 1997 period were considered to be operating at an acceptable level of safety, and 2) in following the NRC's stated goal of "maintain safety," it was concluded that the threshold should identify plants above the industry norm.

LER #	Plant	Year	Description
44391001	Seabrook 1	1991	Personnel error led to a reactor trip. Turbine main feedwater pumps tripped on high steam generator level.
32191007	Hatch 1	1991	Recirculation pumps tripped leading to turbine trip and reactor trip. Turbine main feedwater pumps tripped on high water level.
44693011	Comanche Peak 2	1993	During scram recovery, turbine main feedwater pump tripped.
36695001	Hatch 2	1995	Personnel error caused main turbine trip resulting in reactor trip. Turbine main feedwater pumps tripped on high water level.

Additionally, the INEEL data counted anytime MSIVs go shut outside a normal procedure as seen in the following LERs.

LER #	Plant	Year	Description
37492012	La Salle 2	1992	Following reactor trip, MSIVs shut due to high water level.
23794005	Dresden 2	1994	A failure or instrument air header led to a reactor trip and subsequent closure of MSIVs.
25197002	Turkey Point	1997	Reactor trip due to loss of load (turbine). MSIVs shut because the turbine control valve could not be verified shut.

If condenser vacuum or turbine bypass was not available for decay heat removal following a scram, INEEL classified it as a L2 or L3 respectively and the PI should count the scrams as well.

CONCLUSION

The INEEL study and its methodology is sound. The PI is and should continue to be based on the study with additional refinement of definitions for clarification and simplicity. The data within the study, is robust enough not to be affected by minor changes. As a result, the thresholds will not change based on fluctuations in the number of events or minor inaccuracies in the data. Based on the INEEL data, the staff concludes it is consistent and appropriate to categorize any turbine driven main feedwater pump trip or MSIV closure, for whatever reason, as not easily recoverable, but the staff will apply reason to make a valid and workable definition for the PI as seen below.

FUTURE 99-02 CHANGES

Although the guidance in NEI 99-02 is adequate for this interpretation, future revisions should include the following definition of easily recovered as well as additional specific guidance on what instances meet the criteria of the PI. Easily recovered should be defined as follows:

> *Easily recovered* means recovery actions must be contained in a written procedure and must be uncomplicated (a single action or a few simple actions). The intent of this paragraph is to allow licensees to take credit for recovery actions that are virtually certain to be successful (i.e., probability nearly equal to 1) during accident conditions. Under stressful, chaotic conditions otherwise simple multiple actions may not be accomplished with the virtual certainty called for by the guidance (e.g., lift test leads and land wires; or clearing tags). In addition, some manual operations of systems designed to operate automatically are not virtually certain to be successful (e.g., manual operation of HPCI turbine). While the well trained operator would prevail in some cases, this definition is required to maintain a simple straightforward answer in all cases.

Additionally, the following should be included to clarify how to count a scram for the PI:

> The securing or tripping of all operating main feedwater pumps that cause a scram is a scram with a loss of normal heat removal.
>
> The securing or tripping of all operating main feedwater pumps following a scram is also considered a scram with a loss of normal heat removal, with the following exceptions:
> - motor driven main feedwater pumps that are secured or trip, as long as at least one motor driven main feedwater pump can be recovered from the control room without the need for diagnosis or repair
> - main feedwater pumps that trip as designed from a reactor trip/scram signal or a main turbine trip signal, as long as at least one main feedwater pump would not require diagnosis or repair in order to run.

FAQs

Since the beginning of the ROP, 13 FAQs have been incorporated into NEI 99-02 to clarify this PI, and three others have been approved since Revision 2 of NEI 99-02. A few of these responses are not consistent with the data on which the PI thresholds are based considering the current and more complete understanding of how the thresholds were established. The FAQs giving credit for restoring turbine driven main feedwater pumps should not be considered in future interpretations of this PI because the INEEL data that was used to develop the green/white and other thresholds does not give credit for this nor should the PI. The restoration of a turbine driven feed pump is not virtually certain as is the case with starting a motor driven feed pump, so it is therefore considered not easily recoverable. The following serves as a summary of the FAQs that should no longer be used as a precedent in interpreting the PI.

FAQs 204, 248, 249 (1), and 264 shall be considered superceded because the scenarios require the restoration of a turbine feed pump for restoration of the normal heat removal path.

FAQ 310 should also be superceded because diagnosis or repair was required to determine if restoration was possible, and the turbine driven pump is not easily recoverable. If the pump in question were a motor feed pump which is easily recoverable, diagnosis or repair is still required in the situation and the scram with loss of normal heat removal should count.

FAQ 65 should be counted if the total loss of feed caused the scram, but the partial losses should not count as long as the system can still provide adequate decay heat removal.